GMOs IN AGRICULTURE: REAL CONCERNS OR HYPE?

BY

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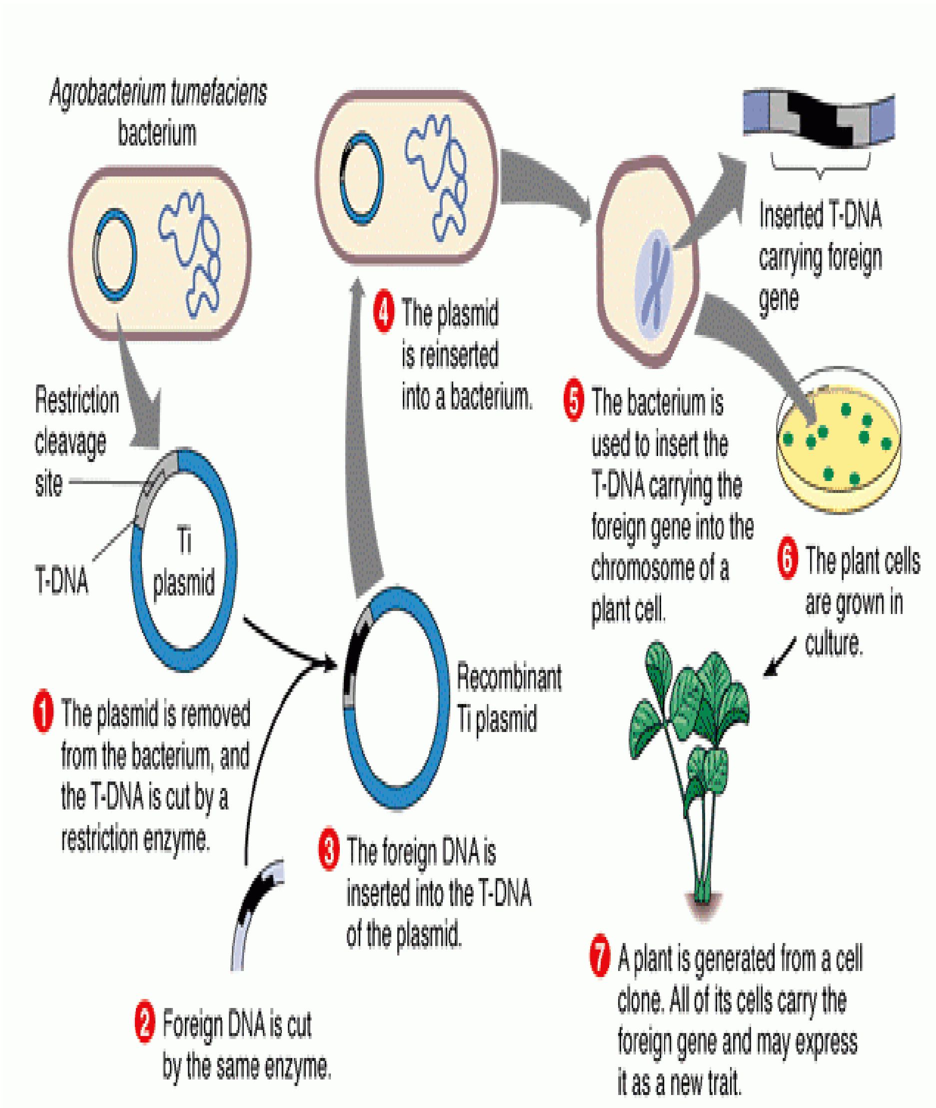
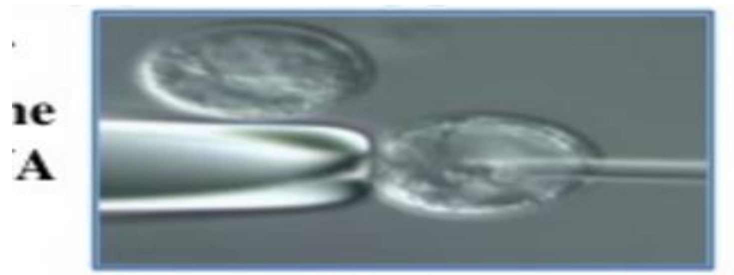
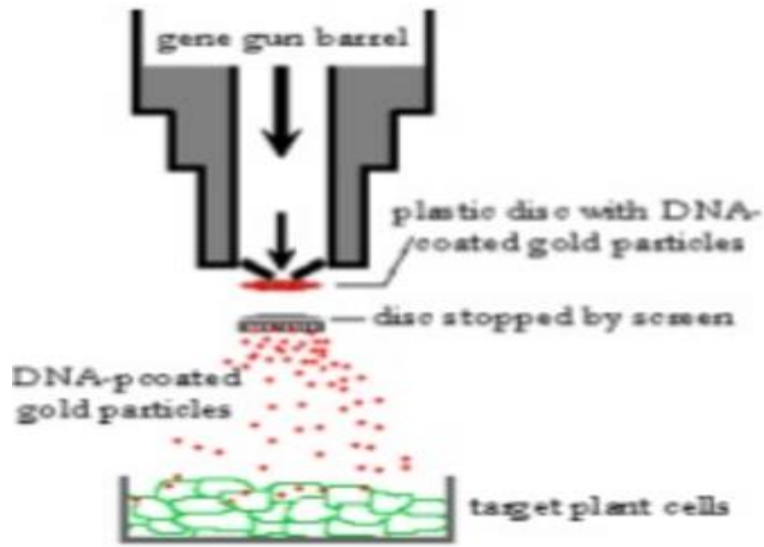
WHAT IS A GMO?

- A Genetically Modified Organism (GMO) is an organism that has had genes from a different species inserted into its genetic code to obtain a desired trait.

HOW IS A GMO MADE?







WHICH ORGANISMS COULD BE MODIFIED?

All organisms theoretically could be genetically engineered and therefore modified

WHICH CROPS ARE MODIFIED

Crop	Source of Inserted Trait	Trait
Corn	Bacteria, other species of corn	Resistance to insects
		Tolerance to herbicides
		Male corn sterility
		Alpha-amylase expression
		Increased lysine level for use in animal feed
		Reduction of yield-loss under water-limited conditions
Cotton	Bacteria	Tolerance to herbicides
		Resistance to insects
Soybean	Bacteria, corn, oats, other species of soybean	Tolerance to herbicides
		High oleic acid soybean oil
		Resistance to insects
	Mustard greens	Regulation of circadian rhythm
Canola	Bacteria	Tolerance to herbicides
		Fertility restoration
		Male canola sterility
	Fungus	Degradation of phytate in animal feed
Potato	Bacteria	Resistance to insects
	Potato viruses	Resistance to potato viruses
	Other species of potato	Lower levels of reducing sugars
		Lower levels of free asparagine
		Reduced black spot bruising
Tomato	Bacteria, potato	Delayed softening
	Bacteria	Resistance to insects
Radicchio	Bacteria	Tolerance to herbicides
		Male radicchio sterility
Alfalfa	Bacteria	Tolerance to herbicides
Sugar beet	Bacteria	Tolerance to herbicides
Rice	Bacteria	Tolerance to herbicides
Apple	Other species of apple	Reduced browning and bruising
Cantaloupe	Bacteria	Delayed ripening
Squash	Viruses	Resistance to viruses
Papaya	Viruses	Resistance to viruses
Flax	Mustard green	Tolerance to herbicides
Plum	Virus	Resistance to viruses
Wheat	Bacteria	Tolerance of herbicides
Creeping Bentgrass	Bacteria	Tolerance of herbicides

Summary of the FDA's Inventory of Completed Biotechnology Consultations on Genetically Engineered Foods as of June 30th, 2015. Crops listed in order of relative abundance of genetically engineered crop consultations (corn having the most consultations).

What GM traits are we talking about?

- **Insecticidal plants (Bt crops)**
- **Herbicide tolerant plants**
- **Gene silencing**
- **Drought resistant plants**
- **Food quality**
- **Biofuels**

SHOULD THEIR PRESENCE IN AGRICULTURE BE A REAL CONCERN OR IS IT A HYPE?

Hype =promoting extravagantly

Real = having actual existence

They should be of real concern because of the following reasons:

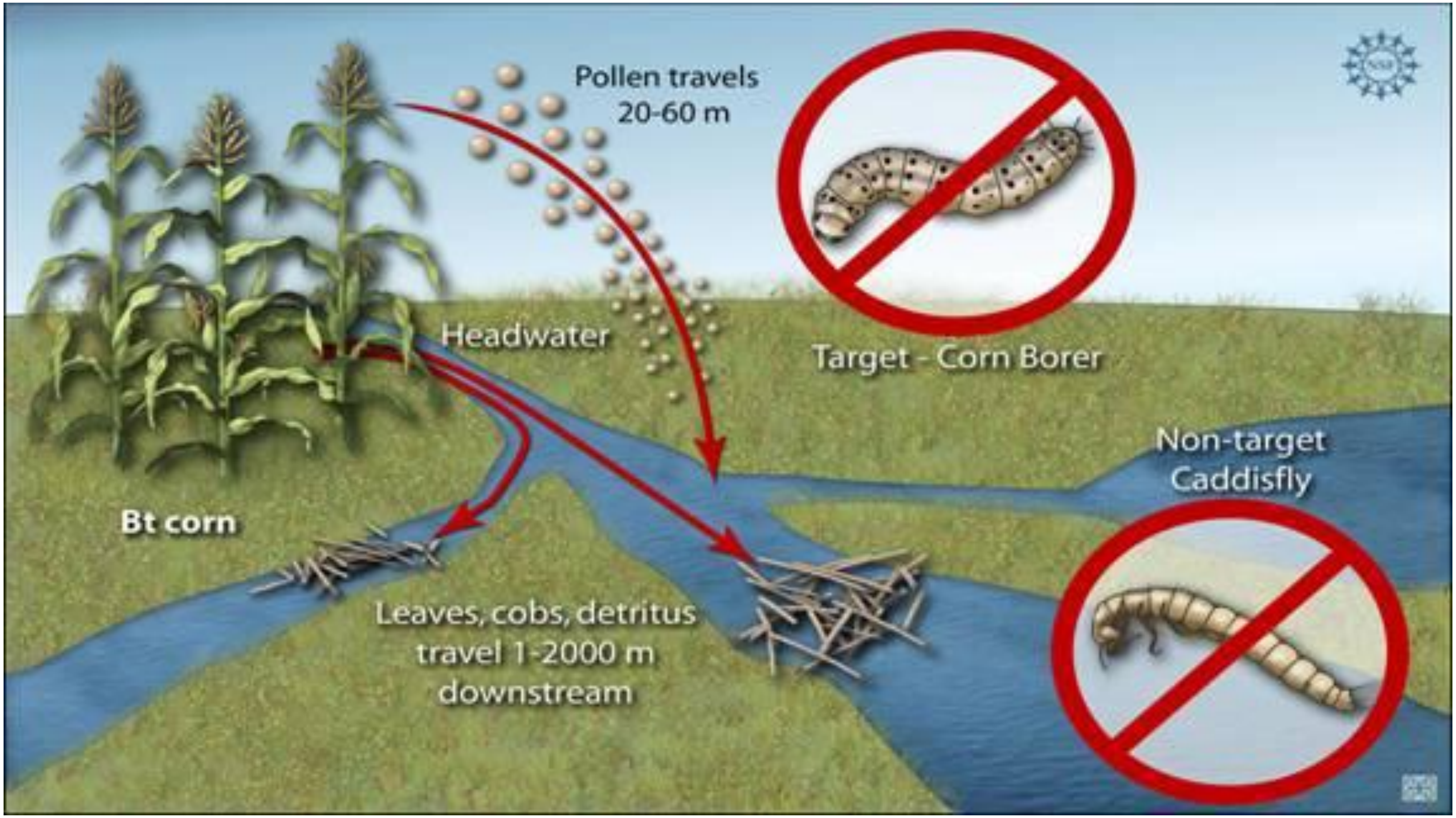
- GENE FLOW
- GENE POLLUTION
- CONTAMINATION OF LOCAL CROPS AND WILD RELATIVES
- CAUSE LOSS OF SEED VIABILITY
- GENE SILENCING
- DISRUPTS ECOSYSTEMS
- HARM NON-TARGET OERGANISMS
- ELIMINATE BIODIVERSITY
- CREATE HEALTH PROBLEMS
- IMPOVERISH THE FARMERS
- INCREASED HERBICIDE/PESTICIDE USEAGE
- WEED/PEST RESISTANCE

PLOS | ONE

RESEARCH ARTICLE

Detection of Transgenes in Local Maize Varieties of Small-Scale Farmers in Eastern Cape, South Africa

Marianne Iversen[1]*, Idun M. Grønsberg[1], Johnnie van den Berg[2], Klara Fischer[3], Denis Worlanyo Aheto[4], Thomas Bøhn[1,5]



Diptera (flies), Coleoptera (beetles) and OTHERS

EARTHWORM, COLLEMBA, HONEY BEE LARVAE,LADY BIRD BEETLE, WASP ETC

GENE SILENCING

UNINTENDED SUPPRESSION OF GENE EXPRESSION

INCREASED HERBICIDE USE

Environmental Sciences Europe
a SpringerOpen Journal

Benbrook ***Environ Sci Eur (2016) 28:3*** **DOI 10.1186/s12302-016-0070-0**

RESEARCH

Trends in glyphosate herbicide use in the United States and globally

Charles M. Benbrook*

Abstract

Background: Accurate pesticide use data are essential when studying the environmental and public health impacts of pesticide use. Since the mid-1990s, significant changes have occurred in when and how glyphosate herbicides are applied, and there has been a dramatic increase in the total volume applied.

Methods: Data on glyphosate applications were collected from multiple sources and integrated into a dataset spanning agricultural, non-agricultural, and total glyphosate use from 1974–2014 in the United States, and from 1994–2014 globally.

Results: Since 1974 in the U.S., over 1.6 billion kilograms of glyphosate active ingredient have been applied, or 19 % of estimated global use of glyphosate (8.6 billion kilograms). Globally, glyphosate use has risen almost 15-fold since so-called “Roundup Ready,” genetically engineered glyphosate-tolerant crops were introduced in 1996. Two-thirds of the total volume of glyphosate applied in the U.S. from 1974 to 2014 has been sprayed in just the last 10 years. The corresponding share globally is 72 %. In 2014, farmers sprayed enough glyphosate to apply ~1.0 kg/ha (0.8 pound/ acre) on every hectare of U.S.-cultivated cropland and nearly 0.53 kg/ha (0.47 pounds/acre) on all cropland worldwide.

Conclusions: **Genetically engineered herbicide-tolerant crops now account for about 56 % of global glyphosate use.**

In the U.S., no pesticide has come remotely close to such intensive and widespread use. This is likely the case globally, but published global pesticide use data are sparse. Glyphosate will likely remain the most widely applied pesticide worldwide for years to come, and interest will grow in quantifying ecological and human health impacts. Accurate, accessible time-series data on glyphosate use will accelerate research progress.

Keywords: Glyphosate, Herbicide use, Genetic engineering, Herbicide-tolerant crops, Roundup, Pesticide use

HERBICIDE/PESTICIDE RESISTANCE

HERBICIDE RESISTANCE

A Growing Threat Down on the Farm

Farmers have become dependent on a herbicide called glyphosate and on crops engineered to resist it. Now, weeds are becoming resistant, and researchers are scrambling for alternatives

CONVENTIONAL WISDOM HAS IT THAT biotech drugs have flourished while genetically modified (GM) crops have foundered because of protests in Europe and elsewhere. Not so. Biotech drugs are doing just fine and, it turns out, so are GM crops. Last year, 10 million farmers in 22 countries planted more than 100 million hectares with GM crops. Over the past 11 years, biotech crop area has increased more than 60-fold, making GM crops one of the most quickly adopted farming technologies in modern history (see figure, p. 1115). Even the European Union is beginning to embrace them, with six E.U countries now planting GM crops.

What's behind this blossoming of transgenics? Oddly enough, a herbicide called glyphosate. The compound is the world's best-selling herbicide by far, prized by farmers for its safety and effectiveness at wiping out hundreds of different kinds of weeds. That effectiveness has not only convinced farmers to make the switch but also prompted seed companies to engineer crops to be impervious to glyphosate's effects. That has allowed farmers to spray their growing crops to wipe out encroaching weeds without fear of wiping out their livelihood. The model has proven so successful that of the transgenic crops planted worldwide last year, approximately 80% were engineered to be glyphosate-resistant (GR). "The rate at which this technology has been adopted floors me," says Donald Weeks, a plant biochemist at the University of Nebraska, Lincoln.

But this success has sown the seeds of its own potential demise. Much of modern agriculture is now dependent on a single chemical. "Glyphosate is as important to world agriculture as penicillin is to human health," says Stephen Powles, who directs the Western Australian Herbicide Resistance Initiative in Perth. It's an apt comparison, because just as pathogens have grown resistant to penicillin and other antibiotics, weeds resistant to glyphosate have recently begun sprouting and spreading around the globe. For now, the scale of the outbreak remains small. But agricultural experts worry that herbicide-resistant weeds are

Superweed. Glyphosate-resistant Johnsongrass in a soybean field in northern Argentina.

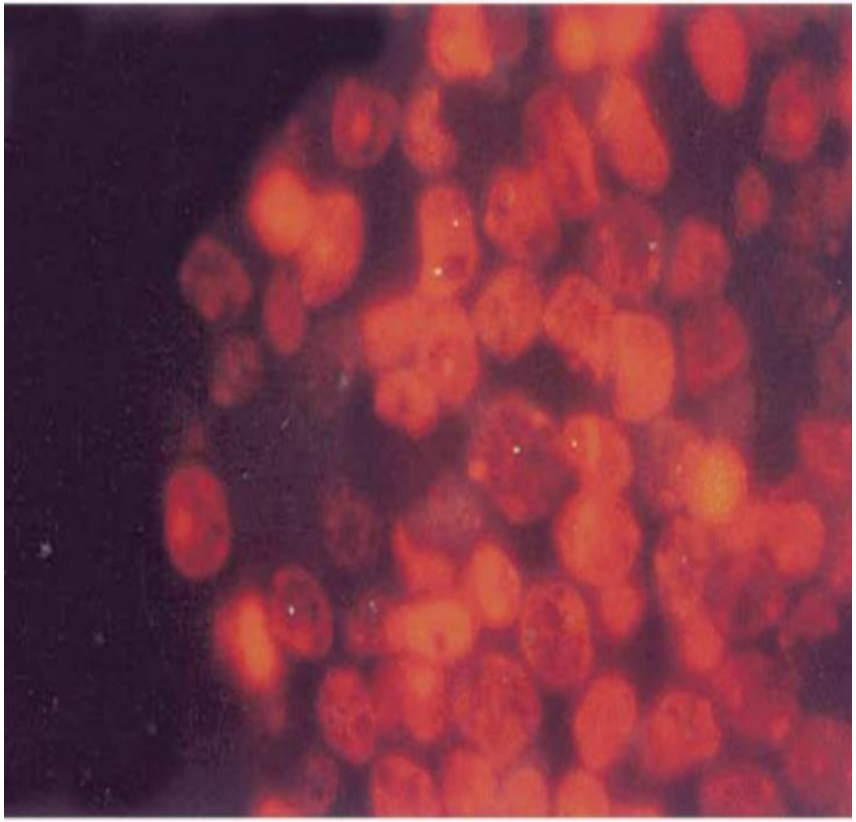
PESTICIDE RESISTANCE

Spraying of a Bt maize field with endosulfan pesticide for *B. fusca* control (2nd application as in conventional maize) –January 2010, Vaalhart, SA

Photo: Angelika Hilbeck

MORE PROBLEMS OF GM

Bt Toxin found in blood samples of pregnant women and in the blood source for fetus (Aris y Leblanc, 2011)



Green Fluorescent protein present in feces

WHAT DO WE DO?

We need a paradigm shift

…to biodiverse, agro-ecological based farming

IAASTD

- International Assessment of Agricultural Knowledge, Science & Technology for Development (2009)

- **"Business---as---usual is no longer an option"**

– High yields and production with industrial farming, high external inputs and high energy consumption

– BUT costs to health, environment and social equity

– Radical over haul of agricultural policy and practice urgently Needed.

- *Main conclusion:* Transition *to organic/ecological/sustainable/resilient agriculture*

IAASTD: Some key findings

- **The future of agriculture lies in biodiverse, agro-ecologically based farming that can meet social, economic and environmental goals**

- **Reliance on resource extractive industrial agriculture is unsustainable, particularly in the face of worsening climate, energy, water crises**

- **Short--term technical fixes, including GE crops, cannot adequately address the complex challenges facing agriculture, and may even exacerbate social and environmental harms**

IAASTD: Some key findings

• Agro-ecological approaches, breeding and marker assisted selection are alternatives, with greater potential to meet future food needs and fewer social and environmental costs

• Achieving food security and sustainable livelihoods requires ensuring access to and control of resources by small--scale farmers, especially women

• Strengthening human and ecological resilience of agricultural systems improves our capacity to respond to changing environmental and social stresses

• Indigenous knowledge and community--based innovations are invaluable part of the solution

GLOBAL NARRATIVE SHIFTING

- UN Special Rapporteur on the Right to Food, Olivier de Schutter (2011):

– "Today's scientific evidence demonstrates that agro-ecological methods outperform the use of chemical fertilizers in boosting food production where the hungry live -- especially in unfavorable environments"

– "We won't solve hunger and stop climate change with industrial farming on large plantations. The solution lies in supporting small--scale farmers' knowledge and experimentation, and in raising incomes of smallholders so as to contribute to rural development."

GLOBAL NARRATIVE SHIFTING

- UNCTAD Trade and Environment Review (2013):

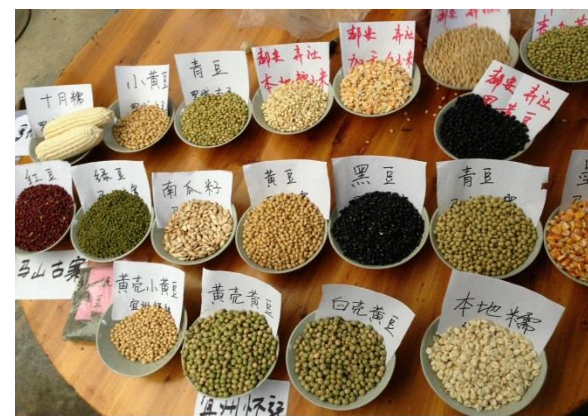
– Recommends a rapid and significant shift away from “conventional, monoculture--based… industrial production” of food that depends heavily on external inputs. Instead, the goal should be “mosaics of sustainable regenerative production systems that also considerably improve the productivity of small--scale farmers and foster rural development”.

- International Symposium on Agroecology for Nutrition and Food Security (2014):

– FAO Director--General Jose Graziano da Silva: ”Agroecology… is an approach that will help to address the challenge of ending hunger and malnutrition in all its forms, in the context of the climate change adaptation needed”

Features of an agriculture for the future

- De--coupled from fossil fuel dependence
- Agroecosystems of low environmental impact, nature--friendly
- Resilient to climate change and other shocks
- Multifunctional (ecosystem, social, cultural and economic services)
- Productive and higher yields with multiple outputs
- Foundation of local food systems
- Rooted in diversity, farmer experimentation and innovation
- Combines scientific inquiry with indigenous and community based research



Why agroecology?

- Can respond simultaneously to multiple socio--economic challenges facing modern food systems

- Highly productive, and especially when multiple outputs of integrated systems are considered

- Capable of sustaining, stabilizing and improving yields, preserving the environment, providing decent employment and secure livelihoods, and directly delivering diverse, nutrient--rich foods in places where needed most

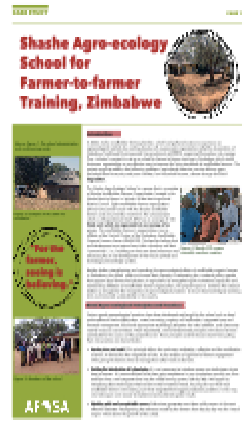
=> Acts as a bypass to industrial agriculture

Agroecology principles

- Recycling of biomass – to optimize nutrient availability and balance nutrient flow
- Favourable soil conditions for plant growth – manage organic matter and enhance soil biotic activity
- Minimize losses of solar radiation, air and water – manage microclimate, water harvesting and soil management through increased soil cover
- Species and genetic diversification of the agroecosystem – in time and space at the field and landscape level
- Enhance beneficial biological interactions and synergisms – promotes key ecological processes and services

Evidence of agroecology performance

- •Evidence--based case for agroecology as the sustainable long--term solution for farming in Africa, and to mobilize African people and civil society to influence decision makers
- • Case studies from diverse countries in East Africa, West Africa, Southern Africa published and uploaded at www.afsafrica.org


Shashe Agro-ecology School for Farmer-to-farmer Training, Zimbabwe


Community-led approach sustains livelihood improvement in Kotoba, Ethiopia


Sand dams bring water and food security to Southeast Kenya


Orange-fleshed sweet potato brings health and livelihood to Pelungu, Ghana

Some key findings

- There have been substantial income increases for farmers practicing agroecology

- Higher crop yields, increased productivity due to improved soil fertility, diversified crops

- Use of drought resistant varieties increases yields

- Organic markets can help increase incomes

- Increased crop diversity lowers risk exposure, increases resilience

Some key findings

- Seed banks provide security in the event of crop failure

- Integration of livestock and agroforestry diversifies farm activities and provide multiple benefits

- Use of diverse local varieties of food crops improves nutrition, health and food security

Some key findings

- **Community--led approaches that focus on knowledge sharing are effective**

- **Famers' groups play important role in spreading agro-ecological practices via farmer--to--farmer networks**

- **There is enhanced social capacity and leadership**

- **Farmers are innovators and holders of a wealth of traditional knowledge**
- **Focus on rural women and youth brings results**

Multiple cropping at Mojo Plantation, India

Photo courtesy of Sujata Lakhani

THANK YOU FOR LISTENING